

**I. Election Restrictions.**

The Examiner required restriction under 35 U.S.C. § 121 between three distinct inventions. The Examiner indicated that invention I was drawn to measuring a shape; invention II was drawn to a semi-conductor inspection and; invention III was drawn to a sensor. Applicant confirms the election of invention II corresponding to previously pending claims 8-13. Applicant's new claims 17-41 are drawn to semi-conductor inspection within invention class II.

**II. Drawings.**

The drawings were objected to under 37 C.F.R. § 1.84(p)(4) with respect to Fig. 3. Applicant has amended Fig. 3 to be consistent with the specification. The Amendment adds no new matter and acceptance of the Amendment is requested.

Figures 5, 11, 12, and 13 were objected to under 37 C.F.R. § 1.84(p)(5) because they include reference signs not mentioned in this description. With respect to Figure 5 Applicant has amended the specification to be consistent with the drawing. Applicant has amended the paragraph beginning at line 30 on page 6 and ending at line 11 on page 7. Acceptance of these changes is requested. This Amendment adds no new matter.

Applicant proposes herewith amendments to Figs. 11, 12 and 13 to make those figures consistent with the specification. A proposed Amendment to Fig. 14 to delineate item 13' more clearly is also being made. A Request for Drawing Change Approval has been submitted along with this Amendment.

**III. Specification.**

The Examiner objected to the disclosure in view of numerous informalities. Applicant has corrected these informalities and requests that the objections be withdrawn.

**IV. Rejections Under 35 U.S.C. § 103.**

The Examiner rejected claims 8-10 under 35 U.S.C. § 103(a) as being unpatentable over Roy et al. (United States Patent No. 5,956,134). The Examiner rejected claims 11-13 under 35 U.S.C. § 103(a) as being unpatentable over Roy et al. as applies to claim 8 in further view of Michael et al. (United States Patent No. 6,173,070). Applicant has cancelled claims 8-13 without prejudice.

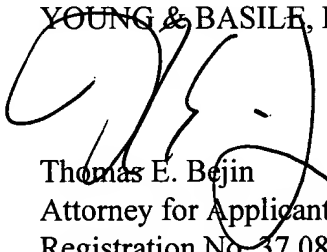
Applicant submits that new claims 17-41 patentably distinguish over the cited art. Neither Roy nor Michael teach or suggest the elements within the claimed method for evaluating the quality of an IC package. Applicant respectfully requests an indication of allowance of these claims.

**V. Conclusion.**

For the previously stated reasons Applicant request that the objections to the drawings and specification be withdrawn. Applicant solicits a Notice of Allowance. If the Examiner feels the prosecution of the present application can be expedited by way of an Examiner's Amendment, the Examiner is invited to contact the Applicant's attorney at the telephone number listed below.

Respectfully submitted,

YOUNG & BASILE, P.C.



Thomas E. Bejin  
Attorney for Applicant(s)  
Registration No. 37,089  
(248) 649-3333

3001 West Big Beaver Rd., Suite 624  
Troy, Michigan 48084-3107

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TEB/sld

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

**In the specification:**

Replace the paragraph on page 1, lines 4 through 6 with the following paragraph:

Under the provisions of 35 U.S.C. 119(e) and Patent Rule 55, Applicant claims the benefit of the following prior provisional application, Application No. [60/257,763]60/157,763 filed October 5, 1999.

Replace the paragraph on page 1, beginning on line 23 through page 2, line 2 with the following paragraph:

The substrate or wafer to which the QFP or BGA attaches includes a corresponding array of pads to which the wires ("leads") of the QFP or balls of the BGA mate. It is of critical importance in the manufacture of electronics that the individual leads or balls are coplanar with one another. If the leads or balls are not coplanar and the IC package is soldered onto a substrate some of the leads or balls may be in electrical contact with the substrate while others will not be. The connections between a BGA and its substrate are not subject to visual inspection. Further, once a BGA is in place it is often easier to discard the entire substrate with BGA if the BGA is faulty. That is if a single IC package on a substrate that potentially contains numerous IC packages [s] is not fully connected, then the entire substrate is defective and must either be repaired or [but in the case of BGAs is often] discarded.

Replace the paragraph on page 4, lines 18 through 21 with the following paragraph:

FIGURE 5 - an alternate representation of [the operation of the sensor/processor of] Figure [3]4 including a plurality of A to D converters, cellular processors, and output shift registers where the output shift registers temporarily store the linear profile.

Replace the paragraph beginning on page 6, line 30 through page 7, line 11 with the following paragraph:

As schematically illustrated in FIGURES 4 and 5 sensor/processor **10** includes a CMOS camera **[10']11**. CMOS camera **[10']11** is preferably a CMOS chip containing a 512 X 512 two dimensional CMOS array made up of pixels arranged in rows and columns. It is understood that the sensor could also be a charged coupled device (CCD) including pixels arranged in rows and columns. The CMOS sensor is made up of a grid of pixels including 512 rows and 512 columns. Light reflected from balls **22** is captured by CMOS sensor **[10']11** and the individual pixels are charged to a representative voltage level. As illustrated in FIGURE 4 the voltage levels from each column are individually read out in parallel to 512 separate A/D convertors **30**. Each column is individually processed by five hundred & twelve separate arithmetical logical units (ALU) **32**. Those of skill in the art would recognize that alternate logical components could be used such as look up tables (LUT) or programmed array logics (PAL). After processing, a linear profile is derived into registers at **34**.

Replace the paragraphs on page 7, beginning at line 19 through page 8, line 5 with the following paragraphs:

The CMOS sensor **[10']11** portion of FIGURE 4 illustrates a single captured image including a profile of a ball **22** obstructed by noise. The plurality of ALU's determines the point within the captured image that represents the laser light line on the ball as compared to the surrounding noise. By reading out the columns of data in parallel as illustrated and described, the present invention measures data and therefore coplanarity at a much faster rate compared to the prior art. ALUs **32** each select a single value or calculate[s] a single value representative of a point on the laser line. While many options

exist, the preferred techniques generally involve[s] smoothing the data from each column and/or thresholding that data. The ALU then chooses the maximum value. This maximum value best represents the laser linear 16 reflected from the BGA.

FIGURE 5 is an alternate illustration of a sensor/processor 10. FIGURE [9]5 includes a 512 X 512 array of photosensors wherein each column includes analog electronics 31. The data are converted to digital values by the analog to digital (A/D) converters 30, processed by a cellular processor 32 and stored in the registers 34.

Replace the paragraph on page 8, lines 21 and 22 with the following paragraph:

Further, the wafer may be evaluated for planarity sampling points from the wafer and setting a second degree polynomial using [at]a least squares method.

Replace the paragraph on page 20 line 6 through 26 with the following line:

As shown in FIGURE [12]17 3D data is simultaneously pre-processed when the 2D data is pre-processed. Pre-processing of the 3D data occurs at 220. The pre-processing of the 3D data is preferably [be] done in parallel with the 2D data processing and measurements, and then held until needed for further processing. The pre-processing of 3D data involves smoothing and filling in the 3D data for further evaluation. This type of pre-processing is preferably performed using order-statistic filtering, such as a median filter. In addition, the data is filtered using non-linear filters that take advantage of the known geometry of the parts. In particular, the highest expected value in altitude is known from the engineering description of the part. In the same fashion, the lowest altitude expected on the part is known to reasonable accuracy. Thus, if any process results in an apparent measurement being taken that exceeds either extreme in altitude, it can be removed without changing the measurement to be taken, since it can be assumed to be spurious. In the case of data where the value is greater than 110% of the predicted value of the height, or top, of the ball, or lead, the data is removed. In addition, any data

that is below the level of the substrate by more than 10% of the substrate's predicted height (z value), or has a height that is less than 90% of the expected height of the substrate, is removed. Spurious data arises from voids found in the substrate, and from apparent heights resulting from the laser beam reflecting off a more distant target as the scan passes over the top of a given target. Removal is important to prevent an abnormal weighting resulting from an abnormally large value, i.e. an unexpectedly large altitude, or depth.